First Semester Examination
Academic Session 2018/2019

December 2018/January 2018

EMT 211 – Engineering Probability & Statistics
[Kebarangkalian & Statistik Kejuruteraan]

Duration : 3 hours
[Masa : 3 jam]

Please check that this paper contains **TEN** **[10]** printed pages including appendix before you begin the examination.

*[Sila pastikan bahawa kertas soalan ini mengandungi **SEPULUH** **[10]** mukasurat bercetak beserta lampiran sebelum anda memulakan peperiksaan.]*

INSTRUCTIONS : Answer **ALL FIVE [5]** questions.
*[**ARAHAN** : Jawab **SEMUA LIMA [5]** soalan.]*

Answer Questions In **English** OR **Bahasa Malaysia**.
*[Jawab soalan dalam **Bahasa Inggeris** ATAU **Bahasa Malaysia**.]*

Answer to each question must begin from a new page.
[Jawapan bagi setiap soalan mestilah dimulakan pada mukasurat yang baru.]

In the event of any discrepancies, the English version shall be used.
[Sekiranya terdapat sebarang percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah diguna pakai.]

1. [a] In a state, the number of women and men are in equal numbers. Assuming that 5% of the men and 0.25% of the women are colour blind, evaluate the probability that

Di sebuah negeri, bilangan wanita dan lelaki adalah sama. Andaikan bahawa 5% daripada lelaki dan 0.25% daripada wanita mempunyai rabun warna, nilaikan kebarangkalian bahawa

(i) A person drawn at random is colour blind.
Seseorang yang dipilih secara rawak mempunyai rabun warna.

(ii) Having drawn a colour-blinded person, this is a male.
Seseorang yang didapati mempunyai rabun warna itu adalah lelaki.

(25 marks/*markah***)**

[b] Given two sets: A and B.

(i) Verify $A \cap (A \cap B')' = B \cap (B \cap A')'$ on the Venn diagram.
Tentusahkan $A \cap (A \cap B')' = B \cap (B \cap A')'$ dengan gambarajah Venn

(ii) Using the set identities, prove that $A \cap (A \cap B')' = B \cap (B \cap A')'$.
Dengan menggunakan set identiti, buktikan bahawa $A \cap (A \cap B')' = B \cap (B \cap A')'$.

(25 marks/*markah***)**

[c] A manufacturing industry advertises that 95% of its online orders are shipped within 2 working days. In order to verify the status, a random sample of 200 out of 10,000 orders received over the past month was audited. Findings revealed that 180 of these orders were shipped on time.

Suatu industri pembuatan mengiklankan bahawa 95% daripada tempahan atas talian dihantar dalam tempoh masa dua hari bekerja. Untuk menentusahkan status itu, 200 daripada 10,000 tempahan diterima pada bulan lepas diaudit. Penemuan menunjukkan bahawa 180 daripada tempahan-tempahan dihantar pada masanya.

(i) What is the sample proportion of orders shipped on time?
Berapakah nisbah tempahan yang dihantar pada masa?

(ii) Does the data sampling condition in this problem satisfy an approximately normal distribution? Explain.
Adakah keadaan pensampelan dalam masalah ini memenuhi syarat suatu anggaran taburan normal? Jelaskan.

(iii) Carry out a hypothesis test at 5% significance level to confirm the manufacturer's claim.
Lakukan ujian hipotesis pada selang keyakinan 5% untuk memastikan kenyataan pengeluar itu.

(50 marks/*markah*)

2. [a] 2% of Mechanical Engineering first year students drive themselves to school.

2% daripada pelajar-pelajar tahun 1 Kejuruteraan Mekanik memandu ke pusat pengajian.

(i) Let X be the number of students who drive themselves to school in a sample of n students. Given $E(X) = 5$ find n.
Biar X bilangan pelajar-pelajar yang memandu ke pusat pengajian dalam suatu sampel n pelajar. Diberi $E(X) = 5$ dapatkan nilai n.

(ii) Using a suitable approximation, calculate the approximation probability that a sample of 80 students would contain at least 1 student who drives to school?
Dengan menggunakan anggaran yang sesuai, kira angggaran kebarangkalian bahawa suatu sampel 90 orang pelajar akan mempunyai sekurang-kurangnya seorang pelajar yang memandu ke pusat pengajian?

(iii) Compare the percentage approximation error from your answer in Q2(a)(ii) with exact solution calculation using Binomial probability distribution.
Bandingkan peratusan ralat anggaran daripada jawapan anda dalam S2(a)(ii) dengan kiraan penyelesaian tepat menggunakan taburan kebarangkalian Binomial.

(30 marks/*markah*)

[b] Determine the mean and standard deviation of the sampling distribution of random samples each of size $n = 36$ are drawn from a population of $N = 1500$ which is normally distributed with mean $\mu = 22.4$ and standard deviation $\sigma = 0.048$, if the sampling is done

Tentukan nilai min dan sisihan piawai bagi taburan pensampelan daripada sampel rawak yang setiapnya bersaiz $n = 36$ dipilih secara rawak daripada populasi $N = 1500$ yang bertaburan normal dengan min $\mu = 22.4$ dan sisihan piawai $\sigma = 0.048$, jika pensampelan dilakukan

(i) With replacement
Dengan gantian

(ii) Without replacement
Tanpa gantian

(iii) Find the probability of random samples having means between 22.39 and 22.41 if the sampling is performed without replacement.
Dapatkan kebarangkalian bagi sampel rawak dengan nilai min antara 22.39 dan 22.41 jika pensampelan dilakukan tanpa gantian.

(30 marks/*markah***)**

[c] A consumer group who was concerned about the mean fat content of a certain grade chicken burger submitted a random sample of 12 chicken burgers to an independent laboratory for analysis. The percentage of fat in each of the chicken burgers found were recorded as follows.

Sekumpulan pengguna yang mengambil berat tentang kandungan lemak purata dalam suatu jenis gred burger ayam telah menghantar sampel rawak sebanyak 12 biji burger ayam kepada sebuah makmal bebas untuk dianalisis. Peratusan kandungan lemak setiap burger yang diperoleh direkodkan seperti berikut.

21	18	19	16	18	24
22	19	24	14	18	15

The manufacturer claims that the mean fat content is less than 20%. Assuming the percentage fat content is normally distributed with a standard deviation of 3, carry out an appropriate hypothesis test at 5% significance level on the manufacturer's claim.

Pengeluar mendakwa bahawa kandungan lemak purata adalah kurang daripada 20%. Andaikan bahawa peratusan lemak bertaburan normal dengan nilai sisihan piawai 3, lakukan ujian hipotesis yang sesuai untuk menguji pernyataan pembekal itu pada selang keyakinan 5%.

(40 marks/*markah***)**

3. [a] The probability that a student with Diploma fails to get exemption from a particular course is 0.1. Suppose that eight students with Diploma applying for the course exemption are selected at random. What is the

Kebarangkalian bahawa seorang pelajar dengan sijil Diploma gagal mendapat pengecualian bagi suatu kursus ialah 0.1. Andaikan bahawa lapan orang pelajar dengan sijil Diploma yang memohon pengecualian kursus itu dipilih secara rawak. Apakah

(i) probability that at most one student will not get exemption?
kebarangkalian bahawa paling banyak seorang pelajar tidak mendapat pengecualian?

(ii) probability that at least 2 but no more than 3 students will not get the exemption?
kebarangkalian bahawa sekurang-kurangnya 2 tetapi tidak melebihi 3 orang pelajar tidak mendapat pengecualian?

(iii) probability that all students will not get exemption?
kebarangkalian bahawa semua pelajar tidak mendapat pengecualian?

(iv) the expected number of students that will not get exemption?
jangkaan bilangan pelajar yang tidak mendapat pengecualian?

(50 marks/*markah***)**

[b] A researcher is interested to find out if there is any significant difference in students' learning time using four training methods. Three students participated in the experiment and the total hours of the students learning time were recorded in Table 3(b(i)).

Seorang penyelidik berminat untuk mencari sama ada perbezaan signifikan dalam masa pembelajaran pelajar dengan menggunakan empat kaedah latihan. Tiga orang pelajar mengambil bahagian dalam eksperimen ini dan jumlah waktu pembelajaran pelajar direkodkan dalam Jadual 3(b(i)).

Table 3(b(i))
Jadual 3(b(i))

Method 1 *Kaedah 1*	**Method 2** *Kaedah 2*	**Method 3** *Kaedah 3*	**Method 4** *Kaedah 4*
10	11	13	18
9	16	8	23
5	9	9	25

(i) Sketch box plots for the four methods (in same graph sketch) for comparison. Compare and describe the distribution of the data.
Lakarkan plot kotak bagi keempat-empat kaedah pembelajaran (dalam lakaran graf yang sama) untuk perbandingan. Bandingkan dan huraikan taburan data itu.

(ii) The results from one-way ANOVA analysis and post-hoc tests performed were shown in Table 3(b(ii)) and 3(b(iii)).
Keputusan analisis daripada ANOVA sehala dan ujian post hoc yang dijalankan ditunjukkan dalam Jadual 3(b(ii)) dan 3(b(iii)).

- **List the hypotheses of the ANOVA test.**
  Senaraikan hipotesis-hipotesis bagi ujian ANOVA itu.

- **Interpret and explain the results of the hypothesis.**
  Tafsir dan jelaskan keputusan hipotesis itu.

Table 3(b(ii))
Jadual 3(b(ii))

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	348.000	3	116.000	11.600	.003
Within Groups	80.000	8	10.000		
Total	428.000	11			

Table 3(b(iii))
Jadual 3(b(iii))

Post Hoc Tests-Multiple Comparisons
Dependent Variable: LearningTime
Tukey HSD

(I) Method	(J) Method	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Method1	Method2	-4.000	2.582	.455	-12.27	4.27
	Method3	-2.000	2.582	.864	-10.27	6.27
	Method4	-14.000*	2.582	.003	-22.27	-5.73
Method2	Method1	4.000	2.582	.455	-4.27	12.27
	Method3	2.000	2.582	.864	-6.27	10.27
	Method4	-10.000*	2.582	.020	-18.27	-1.73
Method3	Method1	2.000	2.582	.864	-6.27	10.27
	Method2	-2.000	2.582	.864	-10.27	6.27
	Method4	-12.000*	2.582	.007	-20.27	-3.73
Method4	Method1	14.000*	2.582	.003	5.73	22.27
	Method2	10.000*	2.582	.020	1.73	18.27
	Method3	12.000*	2.582	.007	3.73	20.27

(50 marks/*markah*)

4. [a] The correlation coefficient between the abrasion wear and load for 21 samples of recycled carbon composites was computed to be 0.80. Find the 95% confidence limits for this coefficient.

Pekali korelasi antara haus lelasan dan beban untuk 21 sampel karbon komposit kitarsemula telah dikira sebanyak 0.80. Kirakan batas keyakinan 95% bagi pekali ini.

Given:
Diberi:

$$\boldsymbol{z = \frac{\bar{x} - \mu}{\sigma/\sqrt{N}} = 1.1513\ log\ \frac{(1+r)}{(1-r)}}$$

and
dan

$$\boldsymbol{\sigma z = (\frac{1}{\sqrt{N-3}}).}$$

(**20 marks**/m*arkah*)

[b] Two correlation coefficients obtained from samples of sizes N_1 = 28 and N_2 = 35 were computed to be r_1 = 0.50 and r_2 = 0.30, respectively. Is there a significant difference between the two coefficients at the 0.05 level? Calculate z value and comment on the null and alternative hypotheses.

Dua pekali korelasi yang diperolehi dari sampel saiz N_1 = 28 dan N_2 = 35 telah dikira sebagai r_1 = 0.50 dan r_2 = 0,30, masing-masing. Adakah terdapat perbezaan yang nyata antara dua pekali pada tahap 0.05? Kira nilai z dan ulaskan tentang hipotesis nil dan alternatif.

(**40 marks**/*markah*)

[c] Fit a least-squares parabola of the form $Y = a_o + a_1X + a_1X^2$ to the set of data in Table 4[c]. It is given that the value of N = 8.

Padankan kuasa dua terkecil parabola di dalam bentuk form $Y = a_o + a_1X + a_2X^2$ untuk set data di dalam Jadual 4[c]. Diberikan nilai N = 8.

Table 4[c]
Jadual 4[c]

X	1.2	1.8	3.1	4.9	5.7	7.1	8.6	9.8
Y	4.5	5.9	7.0	7.8	7.2	6.8	4.5	2.7

(**40 marks**/m*arkah*)

5. [a] Table 5[a] gives experimental values of the pressure P of a given mass of gas corresponding to various values of the volume V. According to the thermodynamic principles, a relationship having the formula $PV^\gamma = C$ where γ and C are constants, should exist between the variables.

Jadual 5[a] memberikan nilai ujian tekanan P pada jisim gas yang sepadan dengan nilai-nilai yang pelbagai isipadu V yang diberikan. Mengikut prinsip-prinsip termodinamik, hubungan yang mempunyai formula $PV^\gamma = C$ di mana γ dan C adalah pemalar, harus terbit daripada pembolehubah tersebut.

(i) Find the value of γ and C.
Carikan nilai-nilai untuk γ dan C.

(ii) Write an equation connecting P and V.
Tuliskan persamaan menghubungkan P dan V.

(iii) Estimate P value when $V = 1000\ cm^3$.
Anggarkan nilai P apabila $V = 1000\ cm^3$.

(**40 marks**/*markah*)

Table 5[a]
Jadual 5[a]

Volume V (cm^3)	54.3	61.8	72.4	88.7	118.6	194.0
Pressure P (Pa)	61.2	49.2	37.6	28.4	19.2	10.1

[b] Based on the data in Table 5[b], determine the coefficient of linear correlation using coding method as shown in Equation 1.

Berdasarkan data di dalam Jadual 5[b], carikan pemalar linear korelasi menggunakan kaedah kod seperti di dalam persamaan 1.

$$r = \frac{N\sum fXY - (\sum f_x X)(\sum f_y Y)}{\sqrt{[N\sum f_x XX - (\sum f_x X)^2]\,[N(\sum f_y YY - (\sum f_y Y)^2]}} \qquad (1)$$

(**30 marks**/*markah*)

[c] From Table 5[b], use the data to calculate standard error of estimate of x, (i) s_x , (ii) s_y and (iii) $s_{x.y}$, thus to verify the formula $r = s_{XY} / s_X s_Y$.

Daripada Jadual 5[b], gunakan data untuk mengira piawai ralat tafsiran bagi x (i) s_x , (ii) s_y dan (iii) $s_{x.y}$ seterusnya tentusahkan formula $r = s_{XY} / s_X s_Y$.

Table 5[b]
Jadual 5[b]

	Volume range (cm^3)						
	40-49	50-59	60-69	70-79	80-89	90-99	Total
90-99				2	4	4	10
80-89			1	4	6	5	16
70-79			5	10	8	1	24
60-69	1	4	9	5	2		21
50-59	3	6	6	2			17
40-49	3	5	4				12
Total	7	15	25	23	20	10	100

(30marks/m*arkah*)

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APPENDIX 1: Formulae
LAMPIRAN 1: Formula

Sample mean of responses from i[th] group, $\overline{x_i} = \frac{\sum_{j=1}^{n_i} x_{ij}}{n_i}$

x_{ij}= the *j*[th] response sampled from the *i*[th] group (population)
n_i= total number of sample (sample size) of group *i*

Grand mean, $\overline{\overline{x_i}} = \frac{\sum X_{ij}}{N}$

X_{ij}= *i*[th] observation/data in the *j*[th] column
N= total number of observations

Sample standard deviation of responses from *i*[th] group,$s_i = \frac{\sum_{j=1}^{n_i} (x_{ij} - \overline{x_i})^2}{n_i - 1}$

Sum of Squares Total, SST = $\sum_{i=1}^{k} \sum_{j=1}^{n_i} \left(x_{ij} - \overline{\overline{x_i}}\right)^2$

Sum of Squares Groups, SSG = $\sum_{i=1}^{k} n_i (\overline{x_i} - \overline{\overline{x_i}})^2$

Sum of Squares Error, SSE = $\sum \sum \left(x_{ij} - \overline{x_j}\right)^2$

Mean Square Groups (MSG) = $\frac{SSG}{k-1}$

Mean Square Error (MSE) = $\frac{SSE}{n-k}$

k = number of groups
n = number of observation/data